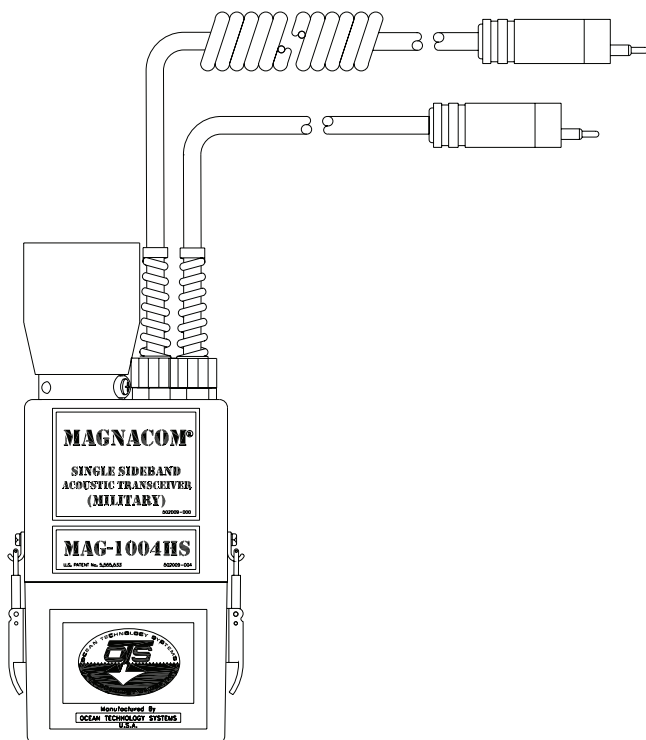


MAGNACOM[®]

SINGLE-SIDEBAND, ACOUSTIC DIVER TRANSCIEVERS (MILITARY)



“TECHNOLOGY IN DEPTH”

- NOTICE -

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- IMPORTANT SAFETY NOTICE -
(Please read before using product.)

It is absolutely essential that all divers are properly trained and equipped and fully understand this user's manual before attempting to use a Magnacom® transceiver.

While the Magnacom® transceivers provides divers with good underwater communications, it does not change or eliminate the potential hazards of diving!

Refer to the Library page of our Web site, www.otscomm.com , for a list of any changes made to this manual since its publication.
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TABLE OF CONTENTS

Section 1: Introduction	1
1.1 General	1
1.2 Specifications	2
Section 2: Equipment Description	4
2.1 General Description	4
2.2 Package Design	4
2.3 Transceiver Adjustments	4
2.4 Voice-Operated Transmitter (VOX or VX)	8
2.5 Push-to-Talk Switch (PTT)	8
2.6 Squelch (SQ)	8
2.7 Side Audio Volume (ST)	8
2.8 Intercom Audio (IV) (MAG-1004HS Only)	8
2.9 Receiver Volume (RV)	9
2.10 Dual Channel Selection	9
2.11 Related Components	9
2.11.1 Dual Transducer (MAG-1002D)	9
2.11.2 Earphone-Microphone (EM) Assemblies	10
2.11.2.1 EMA-2 (911060-001)	10
2.11.2.2 EMA-2SM (911060-098)	10
2.11.2.3 EMX-2 (911060-008)	10
2.11.2.4 EMX-2B (911060-026)	10
2.11.2.5 EMO-2 (900096-686)	10
2.11.2.6 EMH2-1 (911060-009)	10
2.11.2.7 EMH2-1SM (911060-100)	10
2.11.2.8 EMS-2 (911060-017)	11
2.11.2.9 LAR V Adapter (900282-000)	11
2.11.2.10 EMD-2 (911060-067)	11
2.11.2.11 EMD-2SM (911060-101)	12
2.11.2.12 EMDG-2 (911060-076)	12
2.11.2.13 EMH1-1 (900332-000)	12
2.11.2.14 EMH1-1SM (900332-001)	12
2.11.2.15 EMMT-1 (911060-090)	12
2.11.2.16 EMMT-1SM (911060-102)	12
2.11.2.17 EMMT-2 (911060-091)	12
2.11.2.18 EMMT-2SM (911060-103)	12
2.11.2.19 EM-OTS-2 (910369-000)	12
2.11.2.20 EM-OTS-2SM (910379-000)	12
2.12 Microphones	12
2.12.1 ME-16R Hot-Mic® (912086-000)	12
2.12.2 Super Mic® Depth Master	13
2.13 Compatible Surface/Diver Transceivers	14
Section 3: Adjustment and Operating Instructions	15
3.1 General	15

3.2	Inspection of Equipment	15
3.3	Magnacom® Operating Procedures	15
3.4	Adjustments	16
3.4.1	Push-to-Talk (PTT) Button	16
3.4.2	Transmit VOX or PTT	17
3.4.2.1	VOX Adjustment	17
3.4.3	Morse Code Mode (MAG-1002D Only)	17
3.4.4	Channels	17
3.4.5	Squelch Adjustment	17
3.4.6	Volume Adjustment	18
3.5	Rebreather Installation	18
3.5.1	Transceiver Installation	18
3.5.2	Transducer Installation (MAG-1002D Only)	19
3.5.3	Rebreather Adapter Installation	19
3.6	Pre-Dive Checklist	19
3.7	Receiving a Message	20
3.8	Doffing the Diver Units	20
3.9	Examples of Underwater Communication	20
3.9.1	Calls Between Surface, Subs, or Divers	20
3.9.2	Calls Between Divers and Surface, Subs, or Bells	21
3.9.3	Calls Between Surface Units, Subs, and Bells	21
Section 4: Batteries and Charging		22
4.1	Battery Installation or Replacement	22
4.2	Battery Charging	23
Section 5: Advanced User Information		25
5.1	General	25
5.2	VOX	25
5.3	Squelch	28
Section 6: Maintenance and Helpful Hints		29
6.1	General	29
6.2	Periodic Maintenance	29
6.3	Helpful Hints	30
Section 7: Basics of Sound in Water		31
7.1	Background	31
7.2	Factors That Affect Sound in Water	31
7.2.1	Distance	32
7.2.2	Water Density	32
7.2.3	Water Temperature	33
7.2.4	Background Noise	33
7.2.5	Zones of Silence	34
Limited Warranty		36

SECTION 1

INTRODUCTION

Congratulations! You have just purchased one of the finest, state-of-the-art, patented underwater communication systems available. The Magnacom® series are 70-watt, ultrasonic, single-sideband transceivers designed to allow through-water voice communications among divers and users on the surface. Magnacom® employs advanced Digital Signal Processing (DSP) techniques, which ensure the highest quality intelligibility possible. Standard features include automatic electronic switching between VOX and PTT, dual earphones with holders¹, voice-operated transmission (VOX) or Push-to-Talk (PTT) mode, dual channels, a heavy-duty housing, 70 watts of power, and more! In all, Magnacom® is second to none!

The Magnacom® series of diver transceivers is designed for use with virtually all full-face masks and rebreathers with appropriate earphone-microphone assemblies. The interface used for the earphone-microphone assembly can be designed to fit virtually any style rebreather and/or full-face mask. See Section 2.11.2 and Table 1 for compatibility. Special requests are welcome.

1.1 GENERAL

This manual contains information about the Magnacom® underwater communication systems, including most earphone-microphone assemblies and support equipment. Section 1 discusses the functions of the Magnacom® and provides a table of specifications. As an example, a MAG-1004HS transceiver with an EMA-2 earphone-microphone assembly is illustrated in Figure 1.

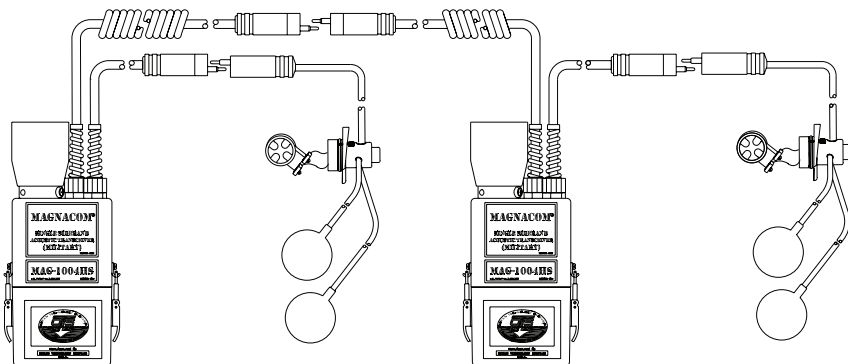


Figure 1

1. Some configurations employ only a single earphone.

1.2 SPECIFICATIONS

Nominal Range:	<u>MAG-1002D</u>	<u>MAG-1003D & MAG-1004HS</u>
	200m to 3000m	200m to 3000m

Note: Environmental variability such as that caused by biological noise and interference, thermoclines, etc., can reduce range. The MAG-1002D's transducers must be at a minimum depth of 6 feet to avoid cavitation, wave cancellation, and reduced range.

Acoustic Output Power:	70 watts PEP (peak envelope power) on Channel A	
Audio Frequency Response:	300–4000 Hz	
Receiver Sensitivity:	–110 dBv	
Automatic Gain Control:	120 dB dynamic range	
Adjustment Controls:	2-turn level controls located on the upper housing (must remove lower battery compartment)	
Adjustment Tool:	Small jeweler-type, flathead screwdriver used to adjust the 2-turn level controls	
Transmitter Activation:	Voice-operated transmitter (VOX) or manual activation (PTT)	
Standard Frequencies ¹ :	<u>MAG-1002D</u>	<u>MAG-1003D & MAG-1004HS</u>
• Channel A:	8.0875 KHz USB ²	28.5 KHz LSB
• Channel B:	11 KHz LSB	32.768 KHz USB
Battery Life:	Assuming 10% transmit time: 4 hours on high-power channel (A) or 8 hours on low-power channel (B)	
Battery Type:	• MAG-1002D: RBL-20B NiMH battery pack, 12 V, 3 amp-hours • MAG-1003D/1004HS: RB-14 NiMH battery pack, 12 V, 2 amp-hours. Includes spring contact pad.	
Low-Battery Indication:	Blinking red LED on upper housing and beep in earphone	
Transducer:	Piezoelectric Broadband Helmholtz Resonator	
Earphone/Microphone:	Ceramic type is standard on most FFMs. Dynamic	

1. Custom frequencies may be ordered; contact OTS for details.

2. “USB” is upper sideband. “LSB” is lower sideband.

	type is optional and allows for greater operating depths/pressures.
Maximum Depth:	500 FSW for MAG-1002D transceiver, 300 FSW for MAG-1003D and MAG-1004HS. <i>Note: The earphone-microphone assembly may affect operating depth. The ceramic earphone can be operated to a depth of 150 FSW. If a greater depth is needed, an EP-1 earphone can be specially ordered to achieve the transceiver's maximum depth.</i>
Operating Temperature:	0°C to 60°C (32°F to 140°F)
Storage Temperature:	–10°C to 60°C (14°F to 140°F)
Connector Type:	Hi-USE®
Housing:	Injection-molded, high-impact, glass-filled ABS plastic
Housing Dimensions:	Height: 10.0” for MAG-1002D, 8.63” for MAG-1003D and MAG-1004HS Width: 3.55” Depth: 1.80”
Battery Chargers:	<i>RC-MAG2</i>: 90–260 VAC, 50–60 Hz input; 24 VDC output <i>RCL-7A</i>: <i>Diver units</i>: 90–260 VAC, 50–60 Hz input; 24 VDC output <i>Surface units</i>: 90–260 VAC, 50–60 Hz input; 16 VDC output <i>RCS-3U-HIU</i>: 90–260 VAC, 50–60 Hz input; 21 VDC output <i>RC-SW-6</i>: 90–260 VAC, 50–60 Hz input; 24 VDC output

SECTION 2

EQUIPMENT DESCRIPTION

2.1 GENERAL DESCRIPTION

The Magnacom® diver transceivers are housed in a watertight enclosure designed for easy belt or tank mounting. For surface operation, our Magnacom® MAG-1001S is fully compatible with the diver transceivers and provides long-range performance. Other compatible surface transceivers are discussed in Section 2.13. Be sure to obtain a surface transceiver that is programmed to operate on at least one of the same channels as the Magnacom.

2.2 PACKAGE DESIGN

The Magnacom® housing is constructed of high-impact, glass-reinforced ABS plastic, which will not corrode if scratched.

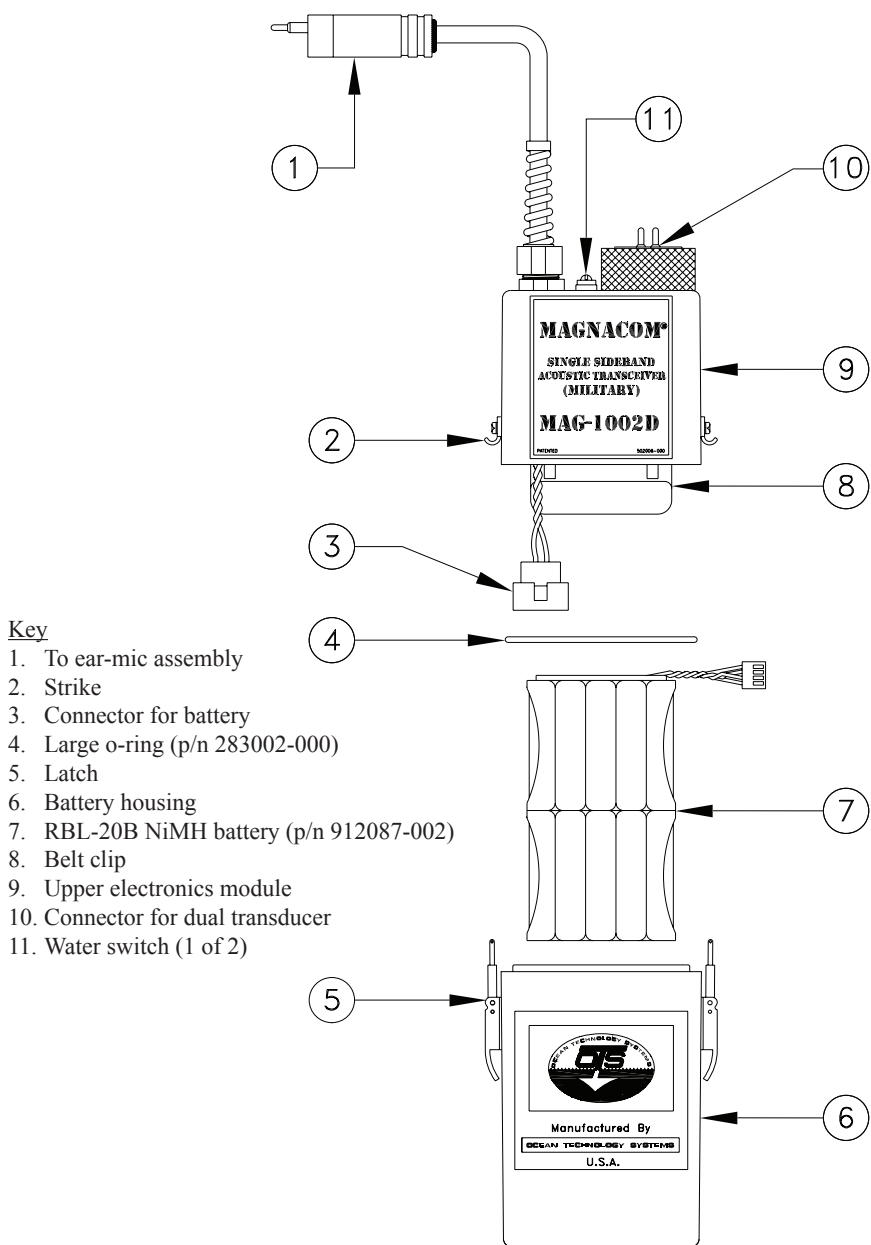
The housing is divided into two major parts (Figure 2): the upper electronics and the lower battery sections. An o-ring between the sections serves to maintain the housing's watertight integrity. Stainless steel latches maintain a constant pressure that preloads the o-ring and prevents leakage within specified depths. (Note: Upper and lower housings are a matched set; do not mix them up with those of other transceivers.)

2.3 TRANSCEIVER ADJUSTMENTS

The Magnacom® transceivers provide adjustment controls for squelch (SQ), voice-operated transmitter (VOX or VX) sensitivity, receive volume (RV), side audio (ST), channel selection, and—on the MAG-1004HS only—intercom volume (IV). Most adjustments are made on the surface, not while diving. There are two options for transmission: VOX (voice activation) and push-to-talk (PTT); the MAG-1002D also provides a third option, Morse code mode. The sensitivity control for the VOX is a two-turn level control located on the bottom of the upper electronics housing (Figure 7, Section 5). This adjustment must be made in a dry environment.

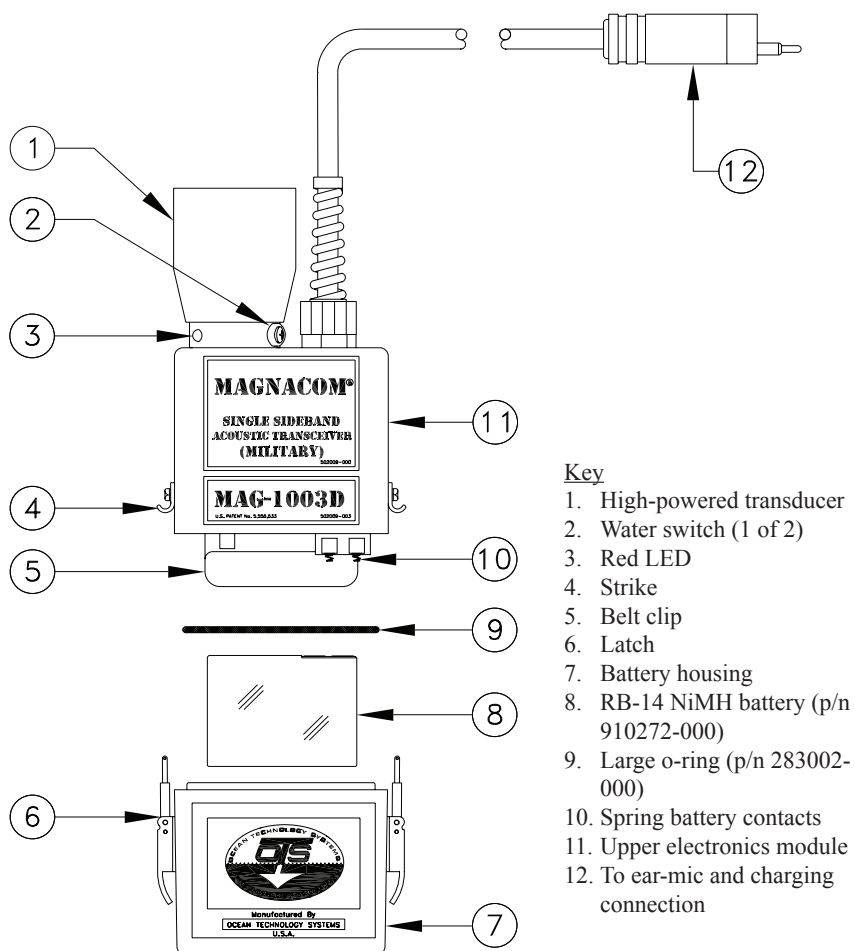
To switch from VOX to PTT or vice versa, simply depress the PTT button three times within 2 seconds. You will hear a double two-tone beep indicating VOX or a single two-tone beep indicating the PTT mode. With the MAG-1002D, holding down the PTT button on the third press switches the unit into Morse code mode, indicated by four tones, long-short-long-short.

The switch for channel selection and all two-turn adjustments for VOX sensitivity, squelch sensitivity, side audio volume, and intercom volume (MAG-1004HS only) are located on the bottom of the upper electronics module. To access these adjustments, remove the lower battery housing and locate the controls on the bottom of the electronics module (Figure 7, Section 5). Adjustments will be discussed fully

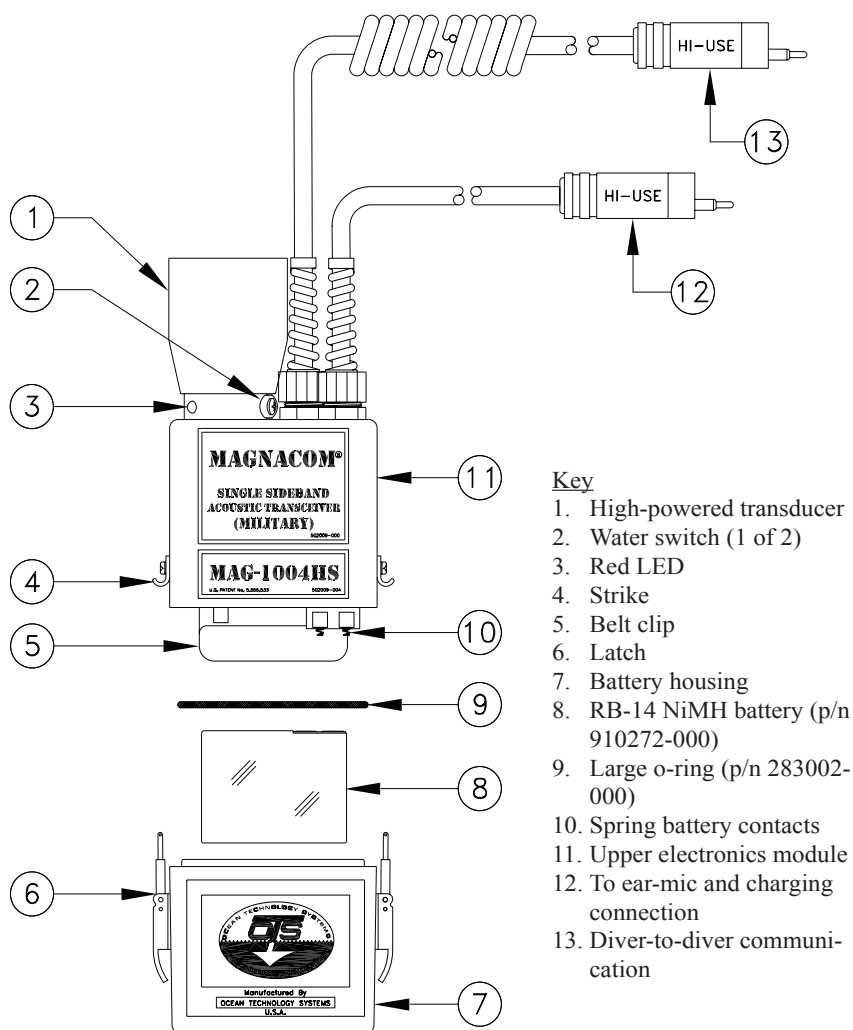


(A) MAG-1002D

Figure 2: Magnacom® components



(B) MAG-1003D



(C) MAG-1004HS

in Section 5, Advanced User Information.

2.4 VOICE-OPERATED TRANSMITTER (VOX OR VX)

VOX operation provides hands-free communications. The user simply talks for the unit to transmit automatically. The VOX sensitivity needs to be set according to the diver's voice. If the VOX is not adjusted properly, false transmission or inability to transmit may occur. If the user is in the VOX mode, he can override it by using the PTT control. Overriding the VOX mode via the PTT switch automatically switches the transceiver to the PTT mode. Tests have shown that most divers favor the PTT mode over the VOX mode.

2.5 PUSH-TO-TALK SWITCH (PTT)

A unique feature of the Magnacom® diver transceivers is their ability to be switched electronically between the VOX and PTT modes while underwater, not only on the surface. The location of the PTT button varies among earphone-microphone assemblies, because of the many different configurations of full-face masks and rebreather mouthpieces. When in the PTT mode, the user simply presses the button to transmit. The system automatically returns to the receive mode upon release of the PTT button. The PTT function overrides the VOX function. The PTT button is also used to switch the transceiver from VOX to PTT or vice versa and, with the MAG-1002D, to enter and exit Morse code mode. Refer to Section 3.4.1 for further instructions.

2.6 SQUELCH (SQ)

The squelch provides a means to limit the background noise heard by the diver. The proper setting depends on the specific requirements of the dive. For most operations a setting of one half turn counterclockwise from fully clockwise is optimum. If long range is desired, use minimal or no squelch. (*Note:* The MAG-1002D with standard frequencies has minimal squelch, to ensure maximum range at all times.) We recommend the use of an increased setting for most SDV training operations or when one is working close-range to other divers and/or the surface station.

2.7 SIDE AUDIO VOLUME (ST)

When you transmit, you will hear yourself via your earphone. This is called “*Side Audio*” (“*Sidetone*,” *ST*). It is useful for verifying that you are transmitting. Some full-face masks or helmets may have a configuration that causes feedback between the microphone and earphones. If this occurs, a lower ST setting is required. Refer to Section 3.4.6 (Volume Adjustment) for more information.

2.8 INTERCOM AUDIO (IV) (MAG-1004HS ONLY)

Your secure diver-to-diver intercom volume is on all the time and allows you to hear yourself and any other diver that plugs in his coiled cord. The two-turn level

control on the bottom of the electronics module allows adjustment of the intercom audio volume. A clockwise turn increases the volume, which typically should be set slightly lower than the other volume settings.

If the MAG-1004HS will be used in through-water mode only, turn down the intercom volume to reduce or eliminate the continuous diver breathing noise for clearer communications.

2.9 RECEIVER VOLUME (RV)

The volume control for all audio signals received through wireless transmission is called “*Receiver Volume*” (*RV*). Each diver hears a little differently and may prefer a loud or soft listening volume. A clockwise turn increases the volume.

2.10 DUAL CHANNEL SELECTION

The Magnacom® diver transceivers have the capability to operate on two different frequencies. We refer to these as channels. The ability to select between channels is a feature useful for dive teams who have more than one group. The diver can select channels only on the surface (not while diving). The channel-select switch is located on the bottom of the upper electronics transceiver and is labeled *A* and *B*. Refer to Section 3.4.4 (Channels) for more information.

The peak output of a transducer ranges over a narrow band of frequencies, so one channel is more efficient than the other. With the MAG-1003D and MAG-1004HS, the transducer output has been optimized for Channel A, so it is more efficient and will provide a longer range than B. With the MAG-1002D, the difference is negligible because of the low frequency levels.

IMPORTANT NOTE: Ensure all the transceivers are on the *same* channel before beginning a dive.

2.11 RELATED COMPONENTS

2.11.1 DUAL TRANSDUCER (MAG-1002D): The standard transducer (Figure 3) is a dual co-phased assembly. It is designed to be installed over the LAR V

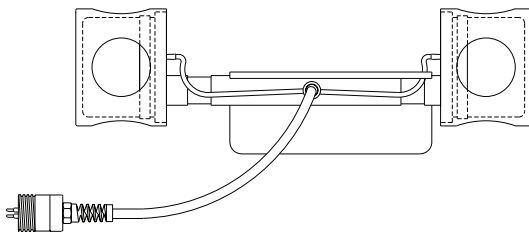


Figure 3

rebreather's oxygen tank. (Other dual transducer configurations are possible via special order.) The dual design ensures the diver's signal is rarely "shadowed" by his suit or equipment.

2.11.2 EARPHONE-MICROPHONE (EM) ASSEMBLIES: Because each full-face mask manufacturer has designed a different communication port for its masks, we have provided different earphone-microphone (EM) assemblies. Table 1 is a compatibility chart with many of the EM assemblies available for the Magnacom® diver transceivers. *Note: If you have a diving helmet or FFM that is not on the compatibility chart, contact OTS or your local OTS dealer to find out if it is available or for a quote to build a custom EM assembly.*

2.11.2.1 EMA-2 (911060-001): The EMA-2 EM assembly is designed for all Divator MK II "AGA" full-face masks (FFMs). It has dual ceramic earphones with earphone holders, an ME-16R Hot-Mic®, a Hi-Use® connector, and a PTT button. The assembly is installed into the Divator MK II FFM communication port.

2.11.2.2 EMA-2SM(911060-098): The EMA-2SM EM assembly is designed for all Divator MK II "AGA" FFMs. It consists of dual ceramic earphones, two earphone holders, the Super Mic® (all-depth, floodable, noise-cancelling microphone), a Hi-Use® connector, and a PTT button. The assembly is designed to install into the Divator MK II FFM communication port.

2.11.2.3 EMX-2 (911060-008): The EMX-2 EM assembly is designed for the EXO-26 *original* FFM. It consists of two dynamic earphones, an ME-16R Hot-Mic, a Hi-Use® connector, and a PTT assembly.

2.11.2.4 EMX-2B(911060-026): The EMX-2B EM assembly is designed for the EXO-26 *standard* FFM. It is similar to the EMX-2 but fits the balanced-regulator version of the EXO-26 with an oral-nasal cavity.

2.11.2.5 EMO-2 (900096-686): The EMO-2 EM assembly is designed to install into the Ocean Reef Neptune NIRA FFM. It consists of two earphones, two earphone holders, an ME-16R Hot-Mic, a Hi-Use® connector, and a PTT button. It installs into a port located on the side of the FFM.

2.11.2.6 EMH2-1 (911060-009): The EMH-1 EM assembly is designed to operate with the HM-2 mouth mask. It consists of an HM-2 mouth mask, a head strap, a ceramic earphone, an ME-16R Hot-Mic, a Hi-Use® connector, and a PTT button (located on the HM-2).

2.11.2.7 EMH2-1SM(911060-100): The EMH-1SM EM assembly is designed to operate with the HM-2 mouth mask. It consists of an HM-2 mouth mask, a head strap, a ceramic earphone, an all-depth Super Mic, a Hi-Use® connector, and a PTT button (on the HM-2).

2.11.2.8 EMS-2 (911060-017): The EMS-2 is an EM assembly designed to

Table 1: Magnacom® Earphone-Microphone Compatibility Chart

<i>Model Number</i>	<i>Part Number</i>	<i>Microphone</i>	<i>Earphone</i>		<i>Mask Type</i>
			<i>Single</i>	<i>Dual</i>	
EMA-2	911060-001	Hot-Mic ⁺		X	All Divator MK II FFM's
EMA-2SM	911060-098	Super Mic ⁺		X	All Divator MK II FFM's
EMX-2	911060-008	Hot-Mic ⁺		X	EXO-26 original FFM
EMX-2B	911060-026	Hot-Mic ⁺		X	EXO-26 standard FFM
EMO-2	900096-686	Hot-Mic ⁺		X	Ocean Reef FFM
EMH2-1	911060-009	Hot-Mic ⁺	X		HM-2 mouth mask
EMH2-1SM	911060-100	Super Mic ⁺	X		HM-2 mouth mask
EMS-2	911060-017	Hot-Mic ⁺		X	ScubaPro FFM
LAR V Adapter	900282-000	Dynamic mic	X		LAR V mouthpiece
EMD-2	911060-067	Hot-Mic ⁺		X	M-48 SuperMask ⁺ FFM
EMD-2SM	911060-101	Super Mic ⁺		X	M-48 SuperMask ⁺ FFM
EMDG-2	911060-076	ME-500		X	Dräger Panorama Nova Dive Mask
EMH1-1	900332-000	Hot-Mic ⁺	X		HM-1 mouth mask
EMH1-1SM	900332-001	Super Mic ⁺	X		HM-1 mouth mask
EMMT-1	911060-090	Hot-Mic ⁺	X		Mantis FFM
EMMT-1SM	911060-102	Super Mic ⁺	X		Mantis FFM
EMMT-2	911060-091	Hot-Mic ⁺		X	Mantis FFM
EMMT-2SM	911060-103	Super Mic ⁺		X	Mantis FFM
EM-OTS-2	910369-000	Hot Mic ⁺		X	Guardian FFM
EM-OTS-2SM	910379-000	Super Mic ⁺		X	Guardian FFM

be installed into the ScubaPro FFM. It consists of two earphones and holders, an ME-16R Hot-Mic, a PTT control, and a Hi-Use® connector.

2.11.2.9 LAR V Adapter (900282-000): The LAR V Adapter is placed between the inhalation hose and LAR V dive surface valve (DSV)/T-bit assembly. It allows basic words to be transmitted without the need for a full-face or mouth mask.

2.11.2.10 EMD-2 (911060-067): The EMD-2 EM assembly is designed for all M-48 SuperMask® FFM's. It consists of dual ceramic earphones, two earphone holders, an ME-16R Hot-Mic, a Hi-Use® connector, and a PTT button. The assembly is designed to install into the M-48 communication port.

2.11.2.11 EMD-2SM (911060-101): The EMD-2SM EM assembly is designed

for all M-48 SuperMask® FFM. It consists of dual ceramic earphones, two earphone holders, an all-depth Super Mic, a Hi-Use® connector, and a PTT button. The assembly is designed to install into the M-48 communication port.

2.11.2.12 EMDG-2 (911060-076): The EMDG-2 EM assembly is designed to be installed into the Dräger Panorama Nova Dive Mask. It consists of two earphones, earphone holders, an ME-500 microphone, a Hi-Use® connector, and a PTT button.

2.11.2.13 EMH1-1 (900332-000): The EMH1-1 EM assembly is designed to be installed into the HM-1 silicone mouth mask. It consists of one earphone, an ME-16R Hot-Mic, a Hi-Use® connector, and a PTT button.

2.11.2.14 EMH1-1SM(900332-001): The EMH1-1SM EM assembly is designed to be installed into the HM-1 silicone mouth mask. It consists of one earphone, an all-depth Super Mic, a Hi-Use® connector, and a PTT button.

2.11.2.15 EMMT-1 (911060-090): The EMMT-1 EM assembly is designed to install into the Mantis FFM. It consists of one earphone, an earphone holder, an ME-16R Hot-Mic, a Hi-Use® connector, and a PTT button.

2.11.2.16 EMMT-1SM(911060-102): The EMMT-1SM EM assembly is designed to install into the Mantis FFM. It consists of one earphone, an earphone holder, an all-depth Super Mic, a Hi-Use® connector, and a PTT button.

2.11.2.17 EMMT-2 (911060-091): The EMMT-2 EM assembly is designed to install into the Mantis FFM. It consists of two earphones, two earphone holders, an ME-16R Hot-Mic®, a Hi-Use® connector, and a PTT button.

2.11.2.18 EMMT-2SM(911060-103): The EMMT-2SM EM assembly is designed to install into the Mantis FFM. It consists of two earphones, two earphone holders, an all-depth Super Mic, a Hi-Use® connector, and a PTT button.

2.11.2.19 EM-OTS-2(910369-000): The EM-OTS-2 EM assembly is designed for all Guardian FFMs. It has dual ceramic earphones w/ earphone holders, an ME-16 Hot-Mic, a Hi-Use® connector, and a PTT button. The assembly is installed into the Guardian FFM communications port.

2.11.2.20 EM-OTS-2SM (910379-000): The EM-OTS-2SM EM assembly is designed for all Guardian FFMs. It has dual ceramic earphones w/ earphone holders, the Super-Mic (all depth, floodable, noise-cancelling microphone), a Hi-Use® connector, and a PTT button. The assembly is installed into the Guardian FFM communications port.

2.12 MICROPHONES

2.12.1 ME-16R Hot-Mic® (912086-000): The ME-16R Hot-Mic is a 150-ohm, water-resistant microphone element. It is a state-of-the art microphone element

Table 2: Compatible Surface/Diver Transceivers

The compatible channel (A or B) of the Magnacom® diver transceiver is provided.

<i>Compatible Model</i>	<i>MAG-1002D</i>	<i>MAG-1003D & MAG-1004HS</i>
BELL-200	8-kHz version	
Buddy Phone®		B
SSB-2010		B
SSB-1001B		A & B
SSB-2001B-2		B
MAG-1003-PS		A & B
MAG-1001S	A & B	A & B
SP-100		B
STX-101		B
STX-101M		A & B
STX-101SB	8-kHz version	

designed to give you long, trouble-free use and the highest intelligibility possible. Although the Hot-Mic is trouble free, it should be maintained. Rinse it with freshwater after use to get all dirt, debris, or salt water from the grill. Dry it with a clean, soft towel. If the element ever needs to be replaced, it is easily removed by unscrewing the two small screws located on its base. Getting the microphone wet does not harm it. However, the microphone element can only withstand an 8- to 10-foot depth/pressure differential. If you removed your diving FFM at the back of the boat and the microphone became wet, there would be no problem; but if the FFM with element dropped more than 8 to 10 feet into the water, the change in pressure probably would damage the microphone element. In tests we have taken off the FFM at 30 feet and replaced it, still at 30 feet, without any problem; but if one were to take off the FFM at 30 feet and drop down to 40 feet, the pressure difference may damage the microphone.

Also, do not allow the microphone to be submerged for more than five minutes. The hydrophobic membrane may saturate and be squeezed, causing damage to the element.

2.12.2 Super Mic® Depth Master: The Super Mic offers patented technology* that overcomes a limitation of other microphones. It can be used at any depth and—unlike the Hot-Mic and many other microphones—can withstand changes in depth while submerged, so it will not be damaged if the diver needs to descend with the

*U.S. Patent no. 7,170,822; EU patent nos. 000458351-0001, -0002, -0003, -0004, -0005, -0006.

mask flooded (e.g., if the full-face mask is removed and stowed when switching to another air system). It has a compact, lightweight design and noise-cancelling characteristics, reducing background noises to provide clearer communications.

When only the highest quality of intelligibility is required, the Hot-Mic is the preferred choice; however, the Super Mic's intelligibility is sufficient for most diving situations.

To assure clear communications when using the Super Mic, it should be no more than 1/4 inch from the corner of the diver's mouth.

After each dive, clean the Super Mic by rinsing it with freshwater and drying it with a clean, soft towel. No other maintenance is required.

Note: Do not press on the microphone diaphragm; doing so may cause damage.

It is possible for the MAG-1003D or MAG-1004HS to transmit sporadically when used with the Super Mic, especially in combination with the KMDSI M-48 Super-Mask. If this problem occurs, see Section 6.3, Helpful Hint #13.

2.13 COMPATIBLE SURFACE/DIVER TRANSCEIVERS

The Magnacom® transceivers can transmit to and receive from other Magnacom® transceivers as well as the Magnacom® MAG-1001S surface unit when on the same frequency and within range. Other compatible transceivers are listed in Table 2.

SECTION 3

ADJUSTMENT AND OPERATING INSTRUCTIONS

3.1 GENERAL

This section contains information for operating Magnacom® through-water transceivers.

3.2 INSPECTION OF EQUIPMENT

Upon arrival of the equipment, inspect the shipping container for dents, gouges, or any other evidence of rough handling.

The Magnacom® transceiver should be visually inspected upon removal from the shipping container. If any damage is evident, immediately file a claim with the carrier. Forward a copy of the damage claim to OTS, see page 36 for contact information. Arrangements for repair or replacement will then be made.

NOTE: Although the Magnacom is rugged in design, care should be exercised to ensure that problems are not caused by improper handling. Store the unit in a safe, secure area after unpacking.

3.3 MAGNACOM OPERATING PROCEDURES

STEP 1: Ensure the batteries are charged and all o-rings are free of debris and in good condition.

STEP 2 (MAG-1002D only): Ensure the transducer cable is securely connected to the dual transducer.

STEP 3: Ensure all internal settings are properly adjusted (squelch, VOX, channel, etc.). See Section 3.4 (Adjustments).

STEP 4: Verify the battery connector wires have not been pinched while securing the upper and lower housings (a pinched wire will cause flooding, which may damage the unit).

STEP 5: Connect together the Hi-Use® connectors of the Magnacom® transceiver and the FFM or LAR V Adapter.

STEP 6: Immerse the diver unit in a pail of water. If testing between 2 units, place each in a separate pail of water. Separate the pails to a distance of approx. 6 feet. When immersed, verify the red LED is illuminated—indicating power is activated. (If unit is a MAG-1002D, it is only necessary to submerge the xducer assembly.) To activate the unit, use a paper clip, bent over and in contact with both water activation screws.

WARNING: Minimal operation through-air is possible, but not recommended. Conditions may arise where transmitter amplification can occur and cause permanent damage to the unit(s).

STEP 7: Ensure they are on the same channel. Using the FFM microphone while the unit is still activated, press the PTT button and talk into the microphone. You should hear yourself through the other diver unit or the surface station. (Note: The range in air is approximately 20 feet.) If using the system in the voice activation mode (VOX), speak loudly with a vowel sound such as “AH” or say the number “FOUR” to trigger the VOX. (Note: A Magnacom® transceiver, when first initiated, will *always* begin in the PTT mode, even if you had it in the VOX mode when it powered down.)

STEP 8: Verify your transceiver is on the same channel everyone else will be using, earphone levels are to your liking, the VOX setting is proper (unless you plan on using only PTT), and the squelch setting is appropriate for the environment and range you require (refer to Section 3.4, Adjustments, for assistance if necessary.) Note: The factory squelch default setting should be appropriate for most operations. Although earphone volume may be too high on the surface, it will be at the proper level during a dive.

STEP 9: Repeat the above procedures with any other transceiver, and verify that it is operational and on the same channel.

STEP 10: After you have verified all transceivers are on the same channel, all settings are as desired, the batteries are fully charged, and the o-ring was installed properly and is clean of debris, you are ready to dive.

NOTE:

- (1) The received communications will not sound as clear during these tests as they will in open water.**
- (2) The units will always start in PTT mode after powering down or up.**
- (3) The VOX setting typically increases in sensitivity when the mask is under pressure.**

3.4 ADJUSTMENTS

The Magnacom® transceivers have a unique feature that allows you to change the transmission mode electronically, either out of the water or in the water. If you depress the PTT button three times within two seconds, you will hear in your earphones either a two-tone beep sequence or a short beep. A two-tone beep sequence indicates the unit is going into VOX mode. A single tone indicates the system is going into PTT mode. (Note: The system requires three *distinct* presses. If the three presses are done too quickly—i.e., three times within 1 second or less—then the system may not switch modes.)

3.4.1 PUSH-TO-TALK (PTT) BUTTON: The PTT button serves two purposes: (1) When pressed and held, you activate the transmitter. As long as you hold the PTT button, you will be transmitting. When you release the button, your transceiver will automatically return to the receive mode. If you are in the VOX mode, you can still depress the PTT to override the VOX. This is useful if your VOX is not adjusted properly and you have trouble activating the VOX. However, if you override the VOX, when you release the PTT button, you will still have the VOX delay (see Section 3.4.2.1, VOX Adjustment). (2) The PTT button is also used to change communication modes. When you click it three times within two seconds, the unit switches from VOX to PTT mode.

With the MAG-1002D, the PTT button serves a third purpose: Pressing it three times while holding the third depression causes the transceiver to enter Morse code mode; to exit this mode, hold the button down and listen for three short beeps.

3.4.2 TRANSMIT VOX OR PTT: When power is first applied, the system defaults to PTT mode. By pressing the PTT button three times within two seconds, the system toggles between VOX and PTT modes and emits a verification tone. A two-tone sequence indicates VOX mode, and a short tone indicates PTT mode.

3.4.2.1 VOX Adjustment: A two-turn level control for adjusting the VOX sensitivity is located on the bottom of the electronics housing. The factory default is a one half to middle setting, which is one full clockwise rotation. The control is a two-turn device with its mid setting at one full revolution from fully counterclockwise or clockwise. Rotating *clockwise increases* VOX sensitivity. A rotation of one eighth is recommended for fine adjustments of either more or less sensitivity. The factory setting is usually sufficient for most voices. Remember to speak close to the microphone (less than 1/4") at higher than normal volume.

3.4.3 MORSE CODE MODE (MAG-1002D ONLY): You can switch from voice mode to Morse code mode by triple-pressing the PTT switch and holding the button down for the third depression. Continue holding it down until you hear a code response, *Dah Dit Dah Dit*. When the transceiver is in Morse code mode, you can send a coded message by using the PTT as a code key. To return to voice mode, press and hold the PTT button until you hear three short beeps.

3.4.4 CHANNELS: To change between channels A and B, open the housing, find the two-position rotary (MAG-1002D) or slide switch located on the electronics module, and place the switch in the desired position. Note: With the MAG-1003D and MAG-1004HS, Channel A is more efficient for long-range communication; with the MAG-1002D, the efficiency of the two channels is approximately equal.

3.4.5 SQUELCH ADJUSTMENT: Open the housing and locate the squelch control. A fully *counterclockwise* position *disables* the squelch. This setting is recommended when it is critical that all communications are received. It ensures reception of all signals, even those buried in background noise. Signals so weak that they are marginally detectable will never unsquelch a unit. For very long-range

communication, the squelch control must be set fully counterclockwise.

If the system is operated at close range and this range will never be increased, a setting of one-and-a-half turns clockwise is good for close-quarter environments (e.g., SDV training operations).

3.4.6 VOLUME ADJUSTMENT: Receive (RV), side audio (ST), and intercom (IV) (MAG-1004HS only) volume adjustments are made inside the electronics module. See Figure 7 (in Section 5).

3.5 REBREATHER INSTALLATION

This section provides instructions for installation of the Magnacom® diver units into a rebreather system. These instructions apply specifically to the LAR V but can be adapted for different rebreathers. Refer to Figure 4 throughout this section.

3.5.1 TRANSCIEVER INSTALLATION: Examine the user's equipment configuration to determine the best location to install and method to secure the transceiver. The type of diving activity and the location of other divers should also be considered for where to install the transceiver to avoid body shadowing and other acoustic obstructions (see Section 7, Basics of Sound in Water); for example, the diver should never carry the transceiver between his body and BCD bladder, because doing so would subdue the acoustic signal.

If a LAR V is being used, the transceiver can be mounted to the LAR V housing with straps (not supplied). Figure 4 shows the transceiver mounted to the LAR V fiberglass shell.

3.5.2 TRANSDUCER INSTALLATION (MAG-1002D ONLY): The dual

Key

- | | |
|-----------------------|--------------------------|
| 1. LAR V adapter | 4. Magnacom® transceiver |
| 2. DSV/T-bit assembly | 5. Retaining strap |
| 3. Rebreather hose | |

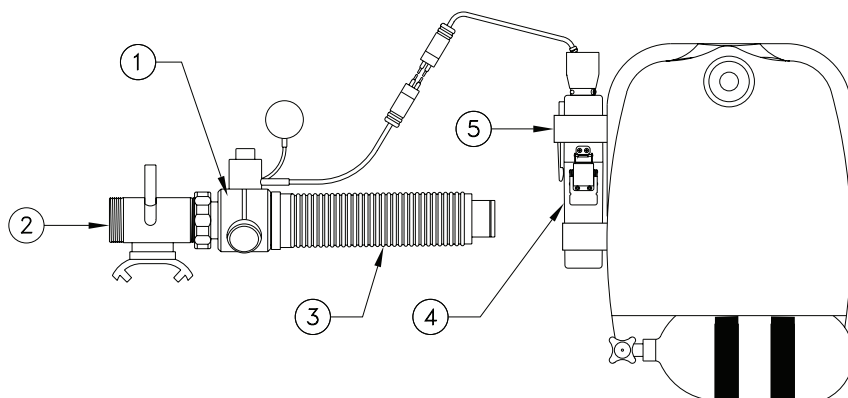


Figure 4: Setup of Magnacom® system with a LAR V rebreather

transducer is installed on top of the oxygen bottle via standard LAR V retaining straps. The straps are passed through slots in the transducer assembly before being stretched around the oxygen bottle and finally affixed to the fiberglass shell.

3.5.3 REBREATHER ADAPTER INSTALLATION: If you use a rebreather adapter (e.g., the LAR V adapter) instead of a full-face or half mask, place the adapter between the dive surface valve (DSV)/T-bit assembly and the inhalation hose.

3.6 PRE-DIVE CHECKLIST

1. Fully charged NiMH battery pack installed (see Section 4).
2. O-rings in place, clamps secure.
3. Diver transceiver in place, with the transducer free of diving equipment obstructions.
4. Earphone(s) adjusted and in position.
5. Hi-Use® connector lightly greased and properly mated.
6. Microphone is tightly secured by screws to the bushings on the nickel wires (ME-16R Hot-Mic only).
7. Diver is dressed out so cables will not snag and the transducer is not covered by any diving equipment.
8. In-water surface check:
 - a. Recheck the location of the earphone(s).
 - b. Submerge the transducer (the waterline should be at the diver's chest level).
 - c. Establish communication.
 - d. Your dive partner's equipment is properly adjusted, and cables are dressed so as not to snag.

NOTE:

Your speech should be considerably slower than normal, and each word should be pronounced clearly and distinctly. Speak one word at a time instead of in flowing sentences. Do not shout, but use slightly loud conversation volume. Minimize exhalation while speaking. Your communication will be more easily understood if you are relaxed, since speech is less intelligible when a diver is anxious.

You should conduct a pool checkout and have more pool practice before using the system in open water. While Magnacom® transceivers provide divers with good underwater communications, they do not change or eliminate the potential

hazards of diving!

CAUTION: Use any standard safe entry into the water, but be aware of the additional equipment you are wearing. The transceiver and cables should be positioned so they do not snag or hit against anything during entry. Keep a copy of this checklist handy for reference before entering the water.

3.7 RECEIVING A MESSAGE

When receiving a transmission:

- Relax.
- Concentrate on hearing.
- Try different earphone positions until the best one is found.
- Minimize exhalation bubble noise, but do not hold your breath. Most divers find that an inhalation cycle is the best time to receive a message. While exhaling, bubble noise makes hearing difficult (with open-circuit scuba).

3.8 DOFFING THE DIVER UNITS

1. Disconnect the Hi-Use® connector from the full-face mask, HM-2 mouth mask, or rebreather adapter. If you are using a rebreather, doff it.
2. As soon as possible after each dive, rinse the unit in freshwater to remove salt and other mineral deposits.
3. Although the Magnacom® transceivers are ruggedly constructed for long life in the marine environment, we strongly recommend that you place your transceiver in a protective carrying case between dives and take special care to avoid damaging the transducer.

3.9 EXAMPLES OF UNDERWATER COMMUNICATION

3.9.1 CALLS BETWEEN SURFACE, SUBS, OR DIVERS: Listen for a break in conversation if others are communicating in the area. Identify whom you are calling and then identify yourself. Continue speaking until the message is complete. At the end of each message, say “OVER” if a response is required and “OUT” if no response is required.

If using the LAR V Adapter, a limited lexicon should be used and practiced among all team members. Speech intelligibility among trained talkers averages around 40%, as verified through word list tests.

EXAMPLE (not using limited lexicon):

DIVER A: Red Diver, this is Blue Diver. Do you see the wreck yet? . . .
OVER.

DIVER B: Blue Diver, this is Red Diver. Yes, I see the wreck, it's ten yards to your right. . . . OUT.

3.9.2 CALLS BETWEEN DIVERS AND SURFACE, SUBS, OR BELLS:

EXAMPLES:

DIVER A: Topside, this is Blue Diver. How far am I from the dive boat? . . . OVER.

SURFACE: Blue Diver, this is Topside. I see your bubbles 50 feet off my port bow. . . . OUT.

DIVER A: Sub, this is Blue Diver. How long before I must lock in? . . . OVER.

SUB B: Blue Diver, this is Sub. We expect you in seven minutes. . . . OUT.

3.9.3 CALLS BETWEEN SURFACE UNITS, SUBS, AND BELLS: Surface units within range can communicate in open water or harbors, thereby avoiding the sometimes crowded and less private channels. Crews of submarines or bells can communicate with one another or with surface units in much the same way. We recommend that standard radio/telephone procedures be used in all communications.

- IMPORTANT SAFETY NOTES -

It is absolutely essential for all divers to be properly trained and equipped before responding to distress, emergency, and safety calls.

WARNING: *Under no circumstances should a diver begin an ascent while holding his breath (air embolism may occur).*

SECTION 4

BATTERIES AND CHARGING

A nickel-metal hydride (NiMH) rechargeable battery and charger are available for your Magnacom® unit. We also offer multi-battery chargers, which give you the ability to charge multiple batteries simultaneously. See Table 3 to determine the appropriate battery and chargers for your Magnacom® product and whether the charger is included or sold separately.

The NiMH battery pack delivers greater capacity than a nickel cadmium (NiCad) battery pack. It also does not suffer from “memory effect” as does a NiCad battery pack.

Note: Due to the self-discharge characteristics of Nickel Metal Hydride (NiMH) batteries, they should be charged upon receipt of the unit and at least once a month to maintain service life.

A battery pack is supplied with your Magnacom® transceiver. Replacement batteries and chargers are available from OTS or your local OTS dealer.

Note: When you receive your battery, it may have upgraded specifications from what is stated in this manual. Due to advancing battery technologies, we continually are upgrading our batteries and chargers. Contact OTS or your OTS dealer to find out the latest available battery and charger.

4.1 BATTERY INSTALLATION OR REPLACEMENT

To install or replace the batteries, follow these steps (refer to Figure 2 for the locations of the transceiver components):

1. Locate the latches on the sides of the Magnacom® transceiver's lower housing. Pull up on the latches simultaneously.
2. Separate the upper and lower modules while being careful not to damage the wires (MAG-1002D only) or o-ring.
3. If you are replacing a currently installed battery, remove the old battery from the lower housing.
4. Install the charged battery by inserting it into the transceiver's lower housing.
 - *MAG-1002D:* With their tapered ends aligned, connect the Molex® connector of the RBL-20B battery to the upper housing's mating connector.
 - *MAG-1003D or MAG-1004HS:* The battery contacts must be oriented so they connect to the springs in the upper electronics housing.
5. Verify that the o-ring is in place, lightly lubricated with a high-grade silicone grease, and free of debris.
6. Carefully mate the upper and lower housings together. Ensure that they line up evenly and that nothing is on the o-ring or mating surface.

Table 3: Magnacom® Batteries and Chargers

<i>Magnacom® Product</i>	<i>Battery</i>	<i>Standard Charger</i>	<i>Charger Included?</i>	<i>Multi-Battery Charger (not included)</i>
MAG-1002D	RBL-20B (part # 912087-002)	RC-MAG2 (part # 900331-000)	No	RCL-7A (part # 900307-000)
MAG-1003D	RB-14 (part # 910272-000)	RC-14i (part # 910273-000)	Yes	RC-SW-6 (part # 910291-000)
MAG-1004HS	RB-14 (part # 910272-000)	RC-14i (part # 910273-000)	Yes	RC-SW-6 (part # 910291-000)

7. Connect the latches from the lower housing to the upper strikes. Pull down the latches simultaneously until fully down. Doing so will spring-load the upper and lower assemblies.
8. Look on all sides of the transceiver to verify the upper and lower assemblies appear evenly matched with no high spots. *Note: If the housing is not completely sealed, water will enter during the dive and may damage the battery.*

4.2 BATTERY CHARGING

Charge the battery pack according to the instructions below, when first purchased and when the power has depleted.

MAG-1002D:

- *RC-MAG2 charger:*

1. Follow Steps 1–3 of Section 4.1 to remove the battery pack from the transceiver.
2. Connect together the Molex® connectors of the RBL-20B battery pack and the RC-MAG2 charger.
3. Connect the charger's power input cord to the AC power source (90–264 VAC, 50–60 Hz).
4. Charge the battery for 14 hours.
5. Disconnect the power input cord from the AC power source and the battery pack from the charger.
6. Follow Steps 4–8 of Section 4.1 to reinstall the battery pack into the transceiver.

- *RCL-7A multi-battery charger:*

1. Follow Steps 1–3 of Section 4.1 to remove the battery pack from the transceiver.
2. Follow the operating instructions in the user's manual provided with the RCL-7A.

MAG-1003D and MAG-1004HS:

• *RCS-3U-HIU smart charger:*

1. Connect the RCS-3U-HIU charger to the transceiver's EM Hi-Use® connector (Fig. 5, #1 and 2).
2. Connect the charger's power input cord (Fig. 5, #4) to the AC power source (90–260 VAC, 50–60 Hz).
3. Charge the battery for 4-6 hours.
4. Disconnect the power input cord from the AC power source and the transceiver from the charger.

• *RC-SW-6 multi-battery smart charger:*

Refer to the RC-SW-6 user's manual for operation instructions (see also Fig. 6).

- IMPORTANT NOTES -

1. *When charging the battery pack for the MAG-1003D or MAG-1004HS, be sure to connect the charger's Hi-Use® connector to the transceiver's EM cable, not to its intercom coiled cord. Charging current applied through the coiled cord will not charge the batteries.*
2. *Do not charge the battery pack for more than 14 hours. Doing so may overheat and damage the battery.*

Key

1. Charger's Hi-Use® connector
2. Non-coiled cord's Hi-Use® connector
3. Coiled cord's Hi-Use® connector
4. AC power input plug

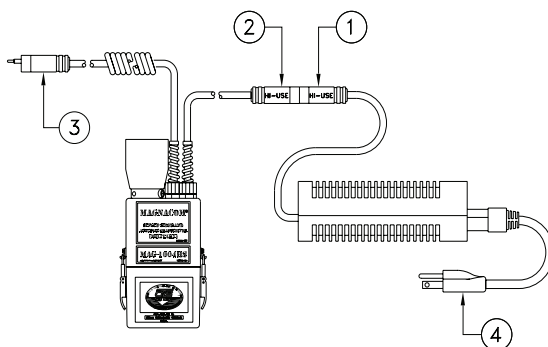


Figure 5

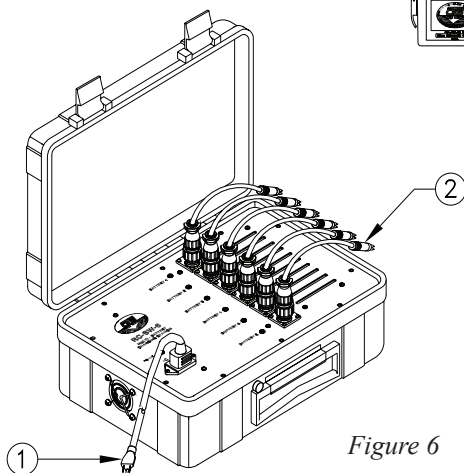


Figure 6

Key

1. AC power input plug
2. Charger's Hi-Use® connectors

SECTION 5

ADVANCED USER INFORMATION

5.1 GENERAL

Although the Magnacom® series is designed so that minimal manual adjustments are necessary, special adjustments are available. These adjustments allow the user to define sensitivities of the VOX and squelch systems, adjust listening volumes, and change channels. Because no standards for design of full-face masks have been established, virtually all full-face masks have different internal designs. Some designs have little room for microphone installation, which makes it necessary to have a more sensitive setting. These advanced adjustments offer the user more options.

When VOX is selected, your transceiver will give you a setting that is either the factory preset or the user's custom setting. If you find that you need more or less sensitivity, you can easily change the factory settings.

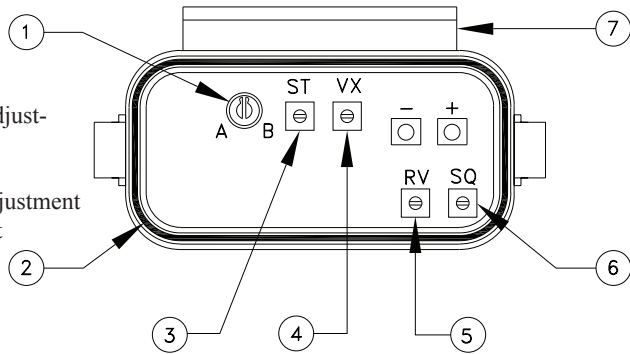
The adjustment controls are located on the bottom of the upper electronics module. The controls include level controls (VOX, side audio volume, etc.) and a switch for changing channels (Figure 7).

5.2 VOX

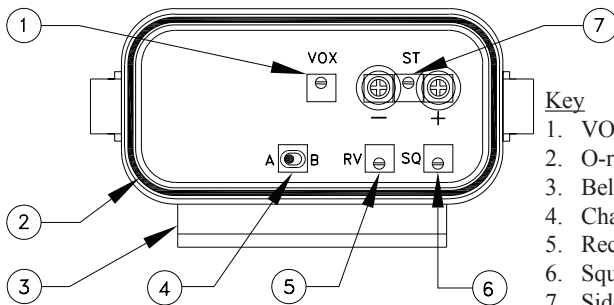
The VOX sensitivity control is labeled "VOX" ("VX" on the MAG-1002D) on the bottom of the electronics compartment and can be accessed by removing the lower battery compartment. The VOX control (Figure 7) can be rotated two times before stopping. Rotation in the *clockwise* direction *increases* the sensitivity. If a VOX high setting is too sensitive, causing false triggering, rotate it counterclockwise until a good setting is found (see Figures 8 through 10 for a graphic look at the effect of rotating the adjustment control). Divers should use a low VOX setting when using an ME-16R Hot-Mic®. The Super Mic® may require a higher VOX setting, but it is a good idea to experiment with it before diving to determine the proper setting. A higher setting should be used if the microphone-mask combination causes the microphone to be farther than a quarter inch from the diver's lips. Figures 8 through 10 illustrate the relationship between the number of turns and sensitivity. CAUTION: *Do not force the control past the stop point, or damage will occur!*

Key

1. Channel selection
2. O-ring groove
3. Sidetone volume adjustment
4. VOX adjustment
5. Receive volume adjustment
6. Squelch adjustment
7. Belt clip



(A) MAG-1002D



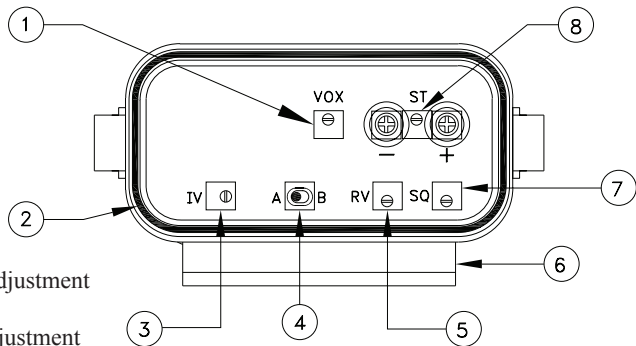
Key

1. VOX adjustment
2. O-ring groove
3. Belt clip
4. Channel selection
5. Receive volume adjustment
6. Squelch adjustment
7. Sidetone volume adjustment

(B) MAG-1003D

Key

1. VOX adjustment
2. O-ring groove
3. Intercom volume adjustment
4. Channel selection
5. Receive volume adjustment
6. Belt clip
7. Squelch adjustment
8. Sidetone volume adjustment



(C) MAG-1004HS

Figure 7: Adjustment Controls

Note for Figures 8–10a: The graphs show the variance in VOX sensitivity with turns of the VOX control. A fully counterclockwise rotation is indicated by 0, and a fully clockwise (two-turn) rotation by 10.

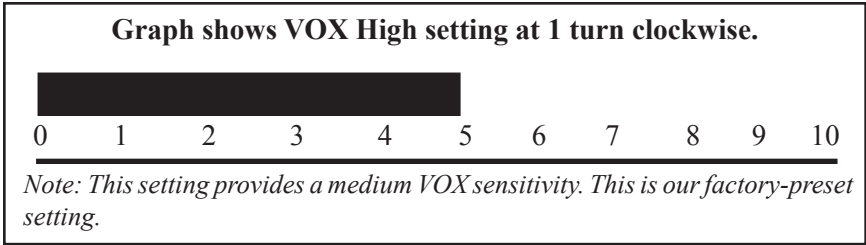


Figure 8

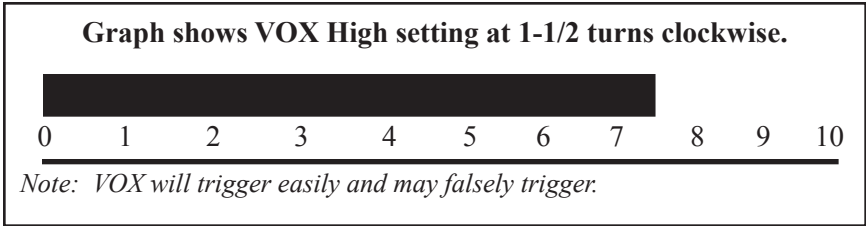


Figure 9

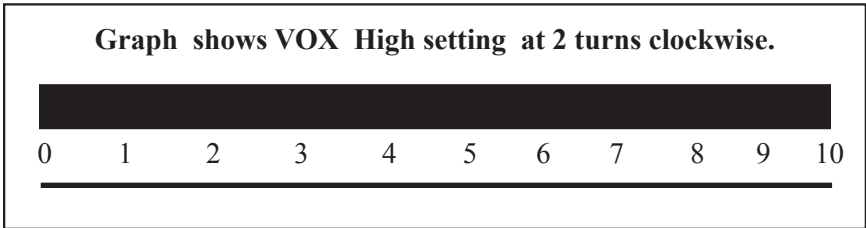


Figure 10

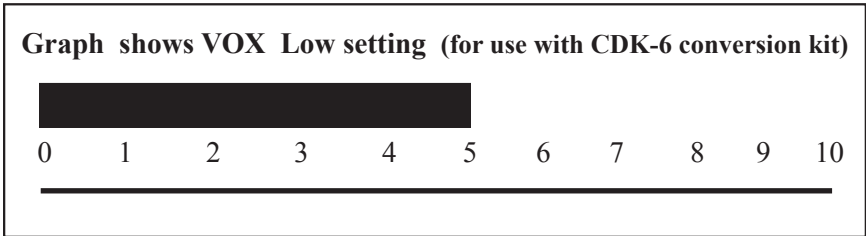


Figure 10a

5.3 SQUELCH

The squelch control (labeled “SQ” in Figure 7) allows the squelch level to be varied. When the squelch is on, the control acts like the squelch control on a CB radio. The squelch adjustment control is a two-turn type. **Clockwise** turns from the beginning point (full counterclockwise rotation) make the unit apply **more** squelch. The more you apply squelch, the quieter the unit becomes; however, the range is reduced (Figures 11–13). The factory-preset “ON” adjustment is set between 1 and 1-1/2 turns clockwise (or 1/2 turn counterclockwise from full clockwise - Figure 12). If you turn the control two turns clockwise, you will decrease your receive range dramatically, so the divers will have to stay within a few feet of each other. If the mission requires long-range communication, the squelch should remain off. Squelch is turned off by a full counterclockwise rotation (where the squelch control cannot be turned any further). ***CAUTION:** Do not force the control past the stop point, or damage will occur!*

Note for Figures 11–13: The graphs show the variance in squelch sensitivity with turns of the squelch control. A fully counterclockwise rotation is indicated by 0, and a fully clockwise (2 turns) rotation by 10.

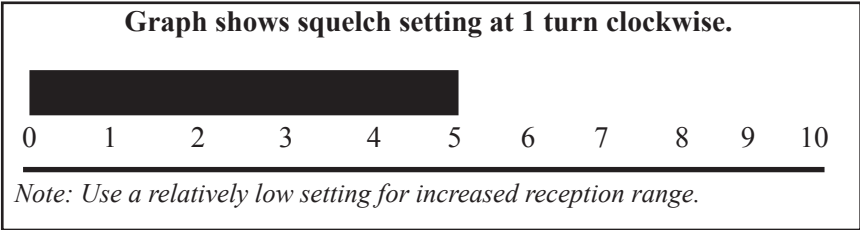


Figure 11

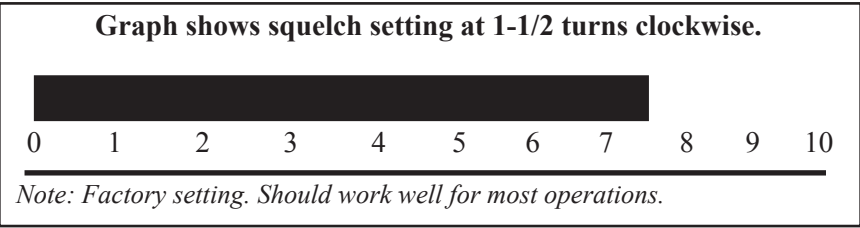


Figure 12

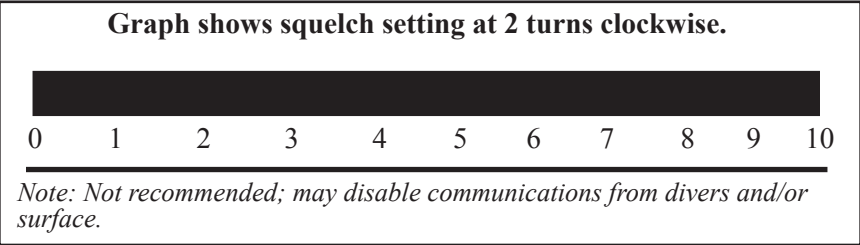


Figure 13

The LOW setting is desired when using the CDK-6 headset and boom microphone. The setting should be about 1 and 1/2 turns from counterclockwise. The control will rotate 2 turns (hence the ability to rotate it more than 1 turn). The LOW setting is also desired when the diver can speak loud enough to overcome breathing and bubble noise. It is suggested the correct setting be established by controlled dives in a pool or similar environment as this makes it easier to experiment with the VOX adjustment in HIGH or LOW settings. When the LOW setting is selected via the voice menu, the sensitivity for all VOX control settings is cut in 1/2. *The lowest reliable setting is the one that works best*, however some soft-spoken persons may find this difficult and prefer a higher setting.

Remember, the more squelch you apply, the less range you can expect. When possible, use the transceiver in the squelch *off* position. Figure 11–13 demonstrate the effect of squelch level adjustment on squelch sensitivity.

If you are using a Super Mic® in combination with a KMDSI M-48 SuperMask®, your transmissions may be sporadic (see Section 6.3, Helpful Hint #13). If you experience this problem, adjust the squelch level to a higher sensitivity. Although more ambient noise may be heard through the receiver, the speech signal will be more likely to activate the receiver squelch consistently, resulting in unbroken speech. If you absolutely need unbroken communication, disable the squelch.

SECTION 6

MAINTENANCE AND HELPFUL HINTS

6.1 GENERAL

The Magnacom® transceivers are virtually maintenance free and should give you many years of service. The following should be done after each day of diving:

1. Rinse the unit with freshwater to remove debris. A mild soap solution can be used, but rinse with freshwater.
2. Dry the transceiver with a clean towel, especially around the area of the activating water-contact screws. Doing so will ensure the unit will shut off. Also ensure you dry the mask microphone. Note: It may take a few minutes for the unit to turn off; this is normal.
3. Store in a dry, safe area.

6.2 PERIODIC MAINTENANCE

The transceivers should have the following service performed periodically:

1. Clean and lightly grease the main housing o-ring. Check the o-ring for cracks or damage, and replace it if there is any evidence. For preventive maintenance, replace the o-ring yearly.
2. Keep the transducer clean, especially from grease (grease decreases performance).
3. Verify the battery springs are in good order and making good contact with the battery pack.

6.3 HELPFUL HINTS

Underwater communication is a useful tool and can save lives when used properly. Training is important and a must for new users. The following are a few helpful hints. Please review and consider them when writing your training plan. (Note: This list is not in order of priority.)

1. Conduct initial underwater training in a controlled area, such as a swimming pool.
2. Speak slowly and pronounce each word clearly.
3. If working in a pool, make sure the pool does not have a defective or noisy pump. This could release numerous tiny bubbles that would reduce range. If after a few minutes you see tiny bubbles (like carbonation) gathering on your hands or dive gear, move to a new location. If the pump is noisy, secure it during the test.
4. Make sure the microphone element is no more than 1/4 inch from the diver's lips (unless using the LAR V Adapter or other rebreather adapter).
5. Ensure all batteries are charged before starting the dive operation.
6. Before the divers enter the water, check to make sure their transducers are not covered by any dive gear.
7. Make sure all cables are dressed to avoid snags while diving.
8. Designate one diver as lead communication diver so both divers will not be trying to answer questions.
9. Brief the divers that after entering the water, especially if making a jump, they should make eye contact with the dive supervisor and establish communications (assuming you have a surface station).
10. In initial training, talk to only one diver at a time until he establishes clear communications. After the divers are comfortable, have the divers talk to each other (assuming you have a surface station).
11. It is a good idea for everyone to agree on Channel A or B before the dive and to ensure all are on that channel.
12. If you feel a thermocline, report the depth to other divers and topside. Topside should adjust the transducer depth accordingly.

13. If you are using a MAG-1003D or MAG-1004HS (or a related transceiver) with a Super Mic[®] microphone, and especially if your mask is a KMDSI M-48 SuperMask[®], you may experience intermittent transmission, resulting in broken speech communication. If this problem occurs, do the following:
- *Intercom volume:* If the transceiver is a MAG-1004HS and will be used in through-water mode only, turn down the intercom volume to reduce or eliminate the diver breathing noise. However, if intercom communications are needed, the intercom volume will need to be adjusted appropriately.
 - *Squelch settings:* The factory setting for the squelch is based on the Hot-Mic's frequency response, which differs from the Super Mic's response in the M-48 mask. Adjusting the squelch to a higher sensitivity level will most likely maintain activation of the receiver squelch during diver speech (although more ambient noise may be heard through the receiver). If you absolutely need unbroken communication, disable the squelch.
 - *Microphone position:* To ensure loud and consistent speech, grab the push-to-talk (PTT) assembly and bend it so you feel the microphone against the corner of your mouth. With a rebreather, there is not enough room to accommodate both the Super Mic[®] and the bite mouthpiece inside the M-48's mask cavity. To allow the maximum amount of speech to enter the microphone, resulting in the loudest and clearest speech possible through the intercom or through-water system, reposition the microphone against the corner of your mouth every time you spit out the bite mouthpiece. When reinserting the bite mouthpiece, gently grab the PTT assembly and move it toward your neck such that the microphone is positioned at the corner of your mouth.

SECTION 7

BASICS OF SOUND IN WATER

7.1 BACKGROUND

If a diaphragm submerged in water is caused to vibrate by electrical means, it has mechanical energy of motion that is communicated to the water. If another diaphragm is submerged in the water near the vibrating diaphragm, the acoustic energy in the water will excite mechanical vibrations in the second diaphragm. These vibrations may be detected by electrical means to complete a flow of mechanical energy from the first diaphragm to the second. The first diaphragm is called the *source* or *transducer*, and the second is called a *receiver* or *hydrophone*. With the Magnacom[®], the transducer and hydrophone are one and the same.

7.2 FACTORS THAT AFFECT SOUND IN WATER

There are many factors that affect the propagation of sound in water. All of these factors vary depending upon location, depth, and time of day. The net result is that

communication in water can be affected by local conditions and the kind and depth of dive being conducted. Fluctuations in range and intelligibility are to be expected.

7.2.1 Distance: The sound intensity from a source varies inversely with the square of the distance from the source. This sort of variation is referred to as *spherical spreading*. Other factors also influence the variation of sound intensity with distance. As the sound passes through the water, some of the energy is absorbed and converted to heat (*attenuation*) and some of the energy is scattered by fish, pilings, seaweed, bubbles, etc. (*diffraction*). In addition, both the surface and bottom may affect the sound intensity by reflecting sound back into the water. The sound reflected by the surface and bottom may raise the intensity above normal levels (*reinforcement*) or may introduce *destructive interference*. The bending of the sound waves by temperature variations also has a great effect on the sound intensity at points remote from the source.

If the source of the sound is near the surface, there is some point beyond which sound is not received from the source. This point is said to be in a *shadow zone*. The distance from the source to the shadow zone is determined by the rate of change of temperature with depth, the depth of the source, and the depth at which the sound is received.

7.2.2 Water Density: In addition to these factors, water density is also important. Because the density of sea water varies with the temperature, the salt content, and

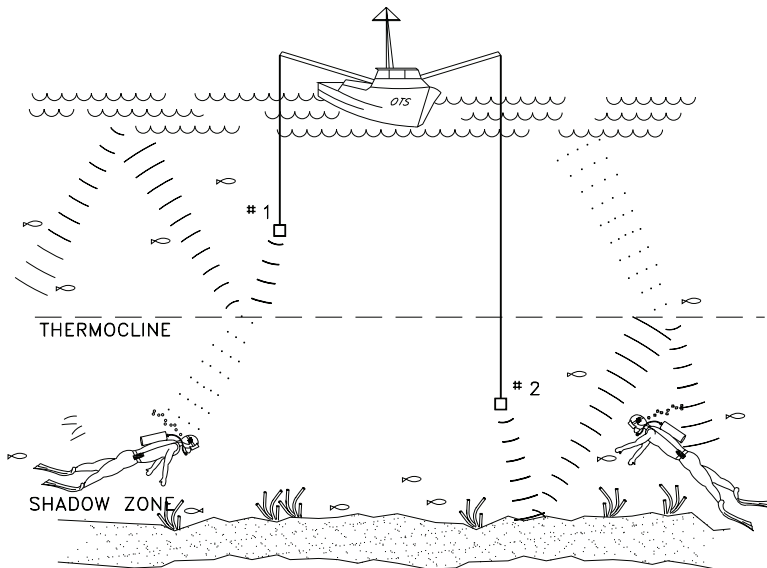


Figure 14: Thermoclines affect the ultrasonic signal. Divers must report thermocline depth(s) so the surface transceiver and/or other divers can be as close to the same depth as possible.

the static pressure, the effect on sound of each of these three factors is usually considered separately.

7.2.3 Water Temperature: Variations in water temperature affect sound transmission most. In some areas of the ocean, the temperature changes at a fixed rate over large ranges of depth. If the temperature increases with depth at a fixed rate, the velocity of sound increases at a rate constant with depth and sound waves are refracted toward the surface. If, however, the temperature *decreases* with the depth (as is frequently the case), the velocity of sound decreases with depth and the waves of sound are bent downward.

There are also areas in the sea where, at some depth, temperature changes rapidly over a small depth range. Such a layer is referred to as a *thermocline* or *thermal layer*. Such layers, in addition to producing rather sharp bending of the sound waves by refraction effects, can serve as reflecting surfaces (Figure 14).

The velocity of sound transmission changes only about one percent for a temperature change of 10°F. However, the resultant bending of the sound path has great effect over a distance of several hundred yards.

If the temperature of the water decreases with depth at the rate of 1°F for each 30 feet (starting at the surface), most of the sound energy originating at the source near the surface will travel along paths that are bent rather sharply downward. Therefore, the sound energy may not reach a shallow detector positioned 1000 yards from the source but may reach a deeper detector position further from the source. Greater temperature variations can cause these paths to bend more sharply.

The best method to deal with thermoclines is to bring the divers and/or transducers as close to each other as possible. If a diver enters a thermocline, he should report it to everyone (surface and divers) so they know the depth of the thermocline. All divers should stay within that depth, and the surface station should try to position the surface transducer below or above, whichever is the case (Figure 14).

7.2.4 Background Noise: Marine organisms play an important role in underwater acoustics. They are important primarily because of the effect they have on sound transmission, but they often serve as sources of underwater noise as well. High background noise—whether man-made, animal, or environmental (waves or rain)—can interfere with good communications. Such background noise can be

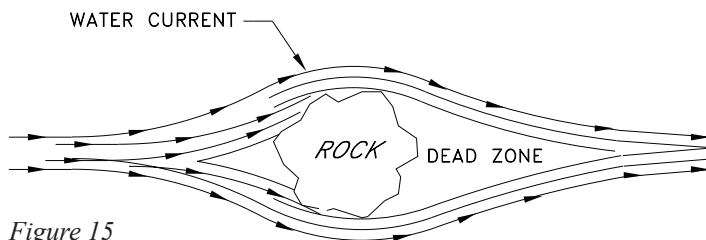


Figure 15

suppressed through the use of the squelch function and thermoclines.

7.2.5 Zones of Silence: Large natural or man-made objects can block acoustical transmission under certain conditions, in much the same way that a rock blocks a fast-moving current of water. Close to the backside of the rock, in this example, the current is absent and the water seems still. A short distance away, the current is flowing again (Figure 15).

Similarly, acoustic energy in the water can be blocked if the transmitting source is close to a large object. On the backside of the blocking object, a “zone of silence” is formed in which reception of the transmitted signal is not possible. Divers can reduce “zones of silence” by moving away from, around, or above the blocking object until communication is reestablished (Figure 16).

Most single sideband signals are efficient enough to permit communications around blocking objects. Reception is made mainly through surface and bottom reflections. Man-made noise may be present underwater in busy harbors, shipping lanes, and many coastal locations, particularly at lower frequencies. The outstanding characteristic of this coastal ambient noise is its great variability from place to place in the same harbor and from time to time at the same place.

Under some conditions, when your diving suit is directly between the transmitting source and your Magnacom[®], a small zone of silence may be created that prevents reception. This effect becomes greater at longer ranges. Turning approximately 45 degrees in any direction eliminates this zone of silence.

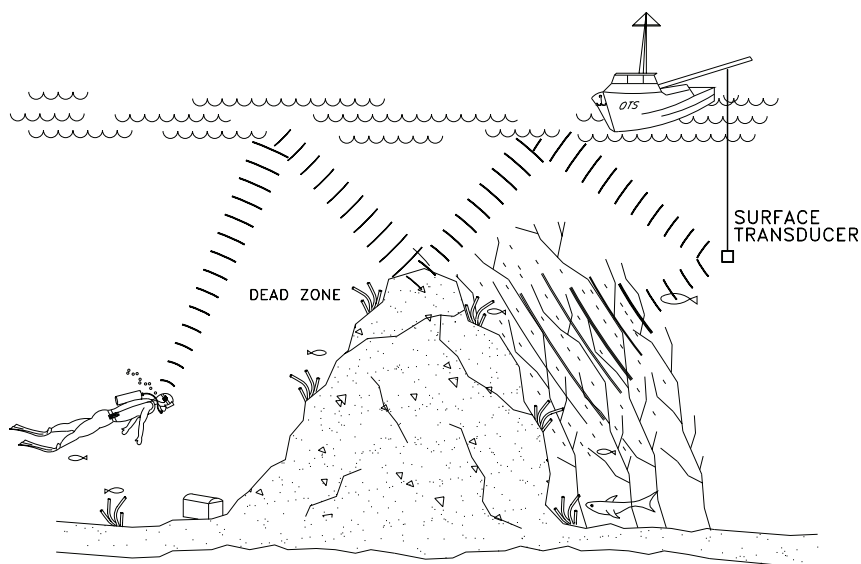


Figure 16: Communication through indirect and direct paths. Note kelp scattering sound. Without surface and bottom bounce, the diver would lose communications.

Since most divers are in constant motion, it is unlikely that anything more than a momentary signal loss would occur when acoustic energy is blocked by air inside a dry suit, by gas bubbles within neoprene wet suit material, or when both are present—such as with a partially inflated dry suit.

- NOTE -

Now that you have read this operator's manual and have become familiar with the system, you are ready for your first communications dive with a Magnacom® transceiver. If you apply what you have learned—especially the proper positioning of the earphone and transducer and slow, deliberate, relaxed speech—you can look forward to a new dimension in underwater experience.

NOTES:

Undersea Systems International, Inc.

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Ocean Technology Systems

LIMITED WARRANTY

Ocean Technology Systems' Magnacom® transceivers are fully warranted against defects in materials and workmanship for a period of one year from the time of purchase. Our obligation under this warranty is limited to the replacement of any part or parts that prove to our satisfaction to have been defective and that have not been misused or carelessly handled. Labor is warranted for one year from time of purchase. The complete unit and/or part must be returned to our factory, transportation charges prepaid. We reserve the right to decline responsibility where repairs have been made or attempted by other than an Ocean Technology Systems factory-trained service center or properly trained personnel. In no event shall Ocean Technology Systems be liable for consequential damages.

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